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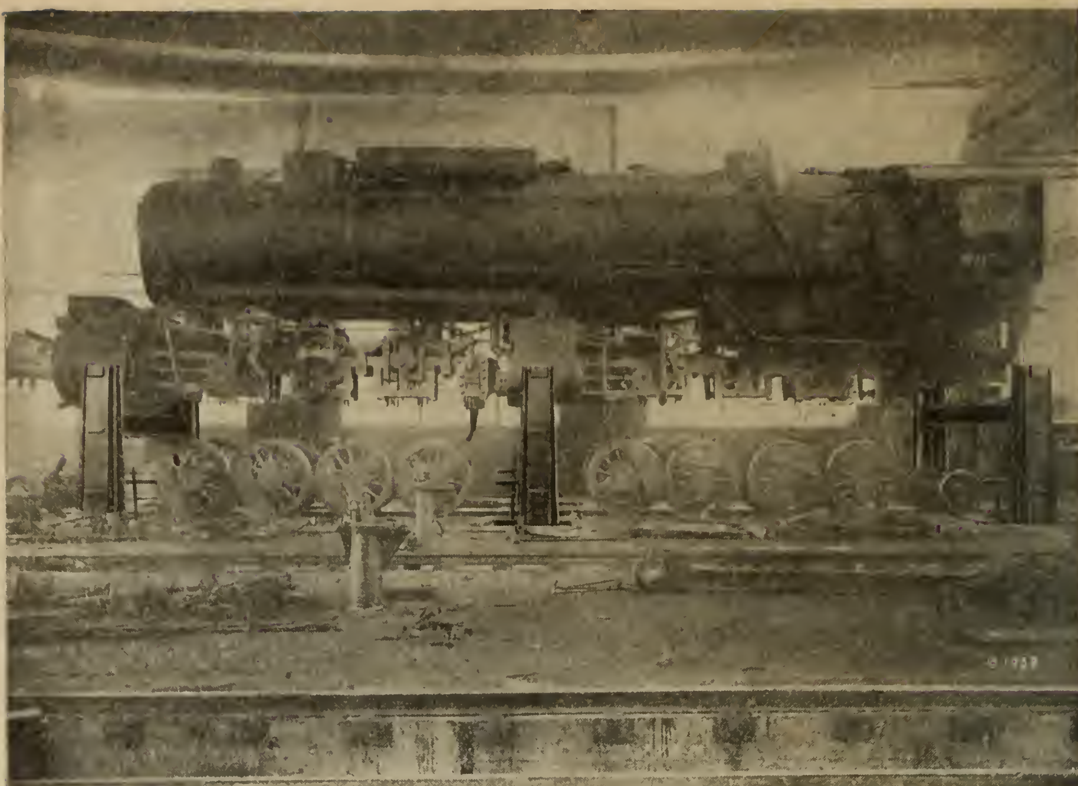

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PROCEEDINGS OF THE CANADIAN RAILWAY CLUB.

Windsor Hotel,
Montreal, Feb. 10th, 1920.

Chairman (Mr. J. Hendry) :—

Gentlemen, please come forward and be seated. You will find attendance cards in the seats which please fill in so that we may have a record of the attendance. The minutes of the previous meeting have already been forwarded to you through the mail and it will not be necessary to read them. I will call on the Secretary to read the applications for membership.

Secretary :—

Mr. President and members, I have received the following applications for membership all of which have already been passed upon by the Executive Committee, and are now submitted for your approval.

New Members.

S. A. Boucher, Salesman for Brandram-Henderson, Ltd., 278 Addington Ave., Montreal.

Thos. Clifford, Asst. Foreman. Canadian Pacific Rly., 454 Hochelaga St., Montreal.

F. J. Domville, Inspector, Motive Power Dept., Grand Trunk Railway, Montreal.

A. F. Dyer, Foreman Welder, Grand Trunk Railway, Montreal.

Thos. Galley, Boiler Shop Foreman, St. Lawrence Welding Co., 138 Inspector Street, Montreal.

Ernest Hawker. Mech. Expert, Galena Signal Oil Co., Moncton, N.B.

J. P. Kenny, Engineer, Robinson Connector Company of Canada, 208 Imperial Bank Bldg., Montreal.

M. A. Miller, Mach. Shop Foreman, St. Lawrence Welding Co., 138 Inspector St., Montreal.

W. J. McEvoy, Yardmaster, Grand Trunk Rly., 2548a Park Ave., Montreal.

Wm. McNown, Shipper, Canadian Pneumatic Tool Co., St. James Street, Montreal.

F. A. Moseley, Rly. Repres. Canadian Fairbanks Morse Co., 84 St. Antoine Street, Montreal.

R. M. Rook, Welding Foreman, St. Lawrence Welding Co., 138 Inspector Street, Montreal.

Maurice Weston, Engineer, Grand Trunk Railway, 111 Brewster Ave., Montreal.

Chairman:—

Gentlemen, you have heard the applications as read. What is you pleasure?

Mr. F. R. Wickson:—

Mr. President, I will move that they be accepted.

Mr. R. Crawford:—

I second it.

Chairman:—

Moved by Mr. Wickson, seconded by Mr. Crawford, that these applications be accepted. All in favor.—Carried.

MEMBERS PRESENT:

Hendry, J.	DeAngelis, G.	Johnston, A.
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Robinson, E. A.	Thorburn, C. C.	Young, Chas. E.
Robinson, E.	Tinkler, J.	Booth, W. A.
Robinson, S. R.	Viberg, E. R.	
Robinson, S. W.	Weston, M.	And others.

President:—

The Secretary has something to say to you in regard to the paper for to-night's meeting.

Secretary:—

Mr. President and gentlemen, I have had a most strenuous time for the past three or four days in connection with this meeting. As you know by the post-cards which were sent out, we were to have had a moving picture illustration on the manufacture of tool steel, to be given by Mr. F. B. Lounsbery, of the Atlas Crucible Steel Co., Dunkirk, N.Y., but he was called away on other important business, and we received a telegram from him on Friday last stating it would be impossible for him to be here to-night. I felt that, as your Secretary, it was up to me to do something quickly, even if it were necessary to prepare a paper myself, and was prepared to do that, but fortunately for you I met a friend of mine, Mr. W. H. Ludington (one of our members), who has kindly consented to give up a paper to-night on Thermit, Electric and Oxy-Acetylene welding, and I have every reason to believe that you will go home thoroughly satisfied with the paper, as in looking around I see quite a number of mechanical men whom I know are going to ask Mr. Ludington many questions before he gets through.

Chairman:

I will now call on Mr. Ludington for his paper.

The subject of welding with the Thermit, Electric and Oxy-Acetylene processes is so broad that I can only hope to cover the more important points. Also I will touch on the subject of cutting with the Oxy-Acetylene flame, which is practically as important as any of the modern welding processes. During the last 25 years there has been developed a number of processes for the joining of metal parts. I refer

particularly to Thermit, Electric and Oxy-Acetylene processes. In the earlier stages of the development of these processes it was commonly believed by the metal trades that each of these processes was competing for the same field, and even to-day it is surprising the number of men indirectly or directly interested in the metal trades who still are of that opinion. Upon second thought it is quite obvious that if any one of these processes was adaptable to the entire field of welding, that process would have been developed at the expense of the other two, assuming of course that it could have covered the field adequately. Even to-day the fields best suited for the different processes, namely, Thermit, Electric and Oxy-Acetylene, are not clearly defined. Generally speaking, each of these processes has a field to which it is best suited, but it is to be expected that these fields will overlap in cases.

It is only to be expected that in the early days the manufacturers of the apparatus used in connection with each of the three processes claimed as large a field as possible for the use of their apparatus, and here let me point out that in the early stages it would have been impossible to have defined these fields, as the commercial interests behind the development were never certain that their partcular apparatus had reached its full development; in fact, the same is true to-day, and by the introduction of a little ingenuity new fields for each process are opened daily.

In view of the by-laws of this club, and also as I represent a Manufacturer and Distributor of apparatus used with the Oxy-Acteylene process, I will not attempt to define the field which the metal trades have found Thermit, Electric and Oxy-Acetylene welding best suited for, but will give you the benefit of the experience of Mr. A. M. Barry, Managing Director of the St. Lawrence Welding Company, Limited, which use all of the three processes in the course of their work and use the process best suited for the job they have in hand.

Statement by Mr. Barry, read by Mr. Ludington.

THERMIT WELDING.

"Thermit welding is used principally for large welds in steel or cast iron. There is practically no limit to welds that can be made in steel by the Thermit process, and the very heavy sections, such as blooming mill press frames in the

steel mills, enormous crankshafts, strong pressure frames, shear frames and rolling mill equipment, such as carbon rolls. It is possible by the Thermit process to build in very large panels and steel gears, also heavy press cylinders can be successfully welded by the Thermit process. In other words, the very heavy welds that require high tensile strength is the Thermit welding field. The reason for this principally is that the weld is made more or less automatically, is cast instantaneously, in fact, the reaction occurs in thirty-five (35) seconds, and after the weld is poured we have a high grade chrome nickel steel weld of great tensile strength.

Electric Welding.

The Electric welding field is one of steel and iron only. It is not possible to successfully weld cast iron by the Electric welding process; by this I mean occasionally there are freak cast iron jobs that can be electric welded. This is helped in some cases by cutting open the frame and drilling and tapping in steel studs, and then lacing over with Electric welding. The result in cast iron is a perfect line of slag between the added metal and the stock on which the weld is placed.

In steel and iron the field is boiler or tank repairs. The advantage of Electric welding over Oxy-Acetylene in this field is that the largest portion of the work resulting from wear on boilers or tanks which occurs in the seams or those parts that have riveted construction. As the Electric welding heat is so concentrated, it is possible to place a weld close to rivets without disturbing the rivets in any way; in fact, a heavy weld can be built up on a seam without the plate becoming red hot. To do this by Oxy-Acetylene would mean a large area of the plate would become white-hot, a smaller area red hot, and we would have the rivet shanks heated up, the diameter of the rivet holes would become smaller owing to expansion, the rivet shanks would be squeezed out of the holes, and it would be impossible to permanently make these rivets tight without replacing them. The Electric welding therefore, has an enormous advantage over Oxy-Acetylene on this class of work. It also has a field in building up steel shafting that has become worn in the bearings. The method used is to add sufficient metal so that the shaft can be turned down to full size of the original bearing.''

Mr. Ludington continues. Mr. Barry's statement will undoubtedly give rise to discussions, as I see present this

evening a number of practical welders and also that Mr. Barry is here, and he can expect that some pointed questions will be put to him. Personally I would like to add to Mr. Barry's statement that it must be remembered that the physical properties of the welds made by the electric welding process, with the exception of a few cases, will never compare with the welds made by the Oxy-Acetylene process. Mr. Barry has omitted to define the field for Oxy-Acetylene welding, believing, I imagine, that I am quite capable of doing this for myself. However, when Mr. Barry has defined what he considers a field for the Electric and Thermit welding prosecces he has not left much for an exponent of the Oxy-Acetylene process to choose from. (Laughter.) Generally speaking, however, Oxy-Acetylene welding has been found by the metal trades more adaptable than the Electric welding for the heavier work, also where the physical properties of the weld is an important factor. While the Oxy-Acetylene flame has a temperature of 6,300 F. and the Electric arc is nearer 9,000 F., in practice the same volume of heat is not available; therefore, the Oxy-Acetylene process with its temperature of 6,300 F. is capable of developing sufficient heat to melt a larger mass of metal and keep the same in a plastic state while being worked with comparatively no danger of burning the metal.

I refer again to the Thermit process. This process requires a great deal of preparation and a mould for every case has to be made. Without referring to the relative expense, the trade have found that all exceedingly large welds, and any welds too large for the Oxy Acetylene process, must be made with the Thermit process. It is interesting to note that the size of weld that can be made by this process is almost unlimited. There is a case on record of a casting being welded up to four tons representing the weight of metal poured.

The development of the more recent processes has been phenomenal, but this can easily be explained when you realize the limitations of the processes that were in vogue before the newer processes were introduced. It did not take the metal trades long to recognize the possibilities, for instance, of the Oxy-Acetylene torch. As you are all well aware, the best known methods of joining metal parts before the newer methods were introduced were forge welding, soldering and brazing.

Forge welding can be defined as a process of bringing the metal parts to be joined up to a temperature at which

the metal is soft and plastic, but not molten; then by bringing these parts into intimate contact, either by the use of pressure or hammering of the parts, until they are united. Practically the only two metals which can be welded this way are wrought iron and low carbon steel. Although high carbon steel and some other metals can be welded by the forge welding process, the welds are not always satisfactory, and the weld itself is never as strong as the parent parts.

Soldering, a process which is familiar to all and used so largely by plumbers, can only be used on light work, mainly sheet, owing to the limitation of the solder itself. Also it can only be used under moderate temperatures, that is, to temperatures slightly above the boiling point of water, as the melting point of common solder is about 400 F.

Brazing, that is the joining of metals by the fusion of a so-called "spelter solder," can be used on metals such as malleable iron, steel, copper, brass and bronze. The brazes are never reliable, and a satisfactory braze can not be made even by an experienced workman unless he is provided with proper equipment affording perfect control of the source of heat, and it is interesting to note that the Oxy-Acetylene torch is used now in brazing and the very best possible results are attained with the process thereby. The principle of brazing metals together is simply using the "spelter solder" as a cement.

Autogenous Welding.

This term is used to describe the type of welding made with the Oxy-Acetylene torch, the principle of which type of welding is that a certain mass of the metal of both parts to be joined is brought up to a plastic state, and are then caused to run into each other. The theory is that at this temperature the metal expanding the molecules separate and interlock, and practice substantiates this theory in as far as it is possible to make a weld, which after being broken will not show any evidences of a join to ordinary observation. However, upon a microscopic analysis, say following an etching of the metals, the fibres of the weld will appear elongated. This is due mainly to the superiority of the adding material which is always a better grade of metal than the parent part, as the adding material is produced in smaller quantities under ideal conditions. The required temperatures for heating the masses of metal is made possible with the Oxy-Acetylene welding torch by virtue of the size of flame, the heat of

flame, and convenient manner in which the flame can be manipulated. You will note that Autogenous welding with the Oxy-Acetylene torch resembles fusion welding to a certain degree.

The term Autogenous welding used to describe the process of welding with the Oxy-Acetylene torch is not strictly accurate. The term means self-produced. Some term should have been adopted in the first instance which also inferred that the weld was Homogenous, that is the same as the parent parts. However, the term Autogenous is so generally accepted that it is doubtful if it will ever be replaced.

Field of Welding. (General.)

The practical application of Oxy-Acetylene and Electric welding processes in the field of manufacture is to replace riveting and other methods of making joints, and also in repair work under conditions where the older processes would have been wholly inadequate. The rapidity with which the joints can be made in many manufactured articles and the comparatively high efficiency of the weld make it of great importance. For instance, in repair work it has made possible the saving of many parts which would otherwise have been scrapped, such as automobile crank cases and some special applications are found in the reclaiming of cracked castings in the foundries, the filling of blow holes in castings, the adding of material to worn surfaces to secure the original thickness, the welding of pipe without removal, the filling of drilled holes that had been incorrectly located, and the sealing of riveted seams to secure absolutely tight joints which cannot be done effectively by caulking. In general the more recent welding processes is used for producing reliable joints in thousands of manufactured articles which were formerly brazed, riveted or bolted together. In many fields the method has revolutionized past methods with corresponding decrease in labor and cost of production.

Cutting.

The Oxy-Acetylene torch is used for cutting out steel shapes, cutting holes in steel plates, cutting of risers from steel castings, cutting structural beams and for cutting up steel wreckage. I might explain to those of you not familiar with Oxy-Acetylene cutting, that the torch used is similar to the welding torch, the main difference being that the cutting

torch provides facilities for turning a jet of oxygen on the metal to be cut after it is preheated.

The cutting with the Oxy-Acetylene torch, the principle of which is to heat the metal with the Oxy-Acetylene flame to a red heat, then by turning on a jet of pure Oxygen, which burns away the metal. The cutting is undoubtedly a process of combustion. The cutting with the Oxy-Acetylene torch at present is practically limited to wrought iron, the different grades of steel, some of which cut easier than others, varying with the carbon contents and nature in which the carbon is found in the steel. The dropping of temperature, due to the forming of a slag on the surface of the kerf cut confines the combustion as desired, and the kerf cut is practically confined to the course of the jet of oxygen.

The history of the development of the Oxy-Acetylene process is extremely interesting. In 1900 the Oxy-Acetylene process of welding had its inception in France, and in 1902 Edmund Fouche, working in conjunction with Picard, developed the first Oxy-Acetylene torch for commercial purposes, but the use of the torch was confined to laboratories until the year 1905, when the process was recognized by the metal trades and taken over by commercial interests, and the extent of development from that date and the present efficiency of the process is almost unbelieveable. In passing I must admit that the metallurgical phase of Oxy-Acetylene welding is of great interest, but not as yet has been studied as thoroughly as will be required for the highest development of the art, although much more research work has been done than is generally supposed by the trade. Of course, a certain amount of metallurgical investigation had to be done in order to develop the art to its present stage.

The development of automatic welding and cutting equipment has solved many difficulties for the manufacturer in such cases as welding automobile bodies, light gauge piping for use in building of automobiles, for such cases as the exhaust pipe gasoline manifold and steering post, also for the welding of gasoline tanks and steel barrels for oil and gasoline. For instance, there is one machine on the market which will weld steel pipe at a speed greater than 16 feet per minute, making a perfect joint. By the use of one of these machines lighter gauge metals can be formed up and welded into piping which results in a pipe of lighter gauge than seamless tubing. with a considerable reduction in the cost of the finished pipe. There is another machine for welding steel barrels. The weld itself is far superior to the ordinary weld made with the hand

torch, and there is no comparison in the speed. In automatic cutting equipment there are machines on the market at present specially adapted for (I have in mind one machine the Oxygraph) which will cut thicknesses of metal up to 10 and 12 inches, the torch being controlled on the pantagraph arm and the tracer is propelled with an electric motor which results in a constant speed in the movement of the cutting torch, which accounts for the remarkably smooth cut that is made,—in fact, the cut in metal with automatic cutting equipment compares favorably with any roughing tool. Another automatic cutting equipment I have in mind is a machine in which the torch is carried on a small carriage propelled by an electric motor, the wheels running in a track. This machine is adaptable to the cutting of circles by using a radius rod, and is used largely in shipbuilding for trimming plates. There are also other machines for such work as making circular cuts, such as port holes, holes and cams in tracks and trimming boiler heads.

Temperature of Flame.

The temperature of the Oxy-Acetylene flame is computed to be about 6,300 F., and is the highest possible temperature obtainable with gases, as perfect combustion is taking place between carbon, the pure fuel and oxygen. When you consider that the melting point of cast iron is approximately 2,100 F., soft steel 2,600 F., and wrought iron 2,700 F., that the temperature obtained with the Oxy-Acetylene flame is sufficient to readily melt any of these metals.

Types.

All the welding torches in use to-day can roughly be classed under two headings, the Injector type and the Medium Pressure type. In the case of the Injector type, the acetylene is fed to the torch at very low pressure, ranging from one to six ounces. In the medium pressure torch the acetylene is fed to the torch at a pressure of from one to six pounds. The actual pressures in each case depend upon the size of tip, which in turn depends upon the thickness of metal to be welded. To describe in detail or further discuss the classification of welding torches would evolve itself into a discussion of the relative merits of the torches placed on the market by different manufacturers, which certainly would not be proper under the circumstances.

The temperature of the Oxy-Hydrogen flame is about 4,000 F. as compared with the Oxy-Acetylene flame at 6,300 F. In this connection it is interesting to note that the number of British-Thermo-Units per cubic foot of gas of the Oxy-Acetylene flame is five times as great as the Oxy-Hydrogen flame.

Oxygen.

Oxygen is generally obtained from suppliers in steel tanks, one, two and three hundred cubic feet capacity, with the gas compressed to approximately 1,800 pounds. There are a few points in connection with Oxygen which I believe will be of interest, namely, the main source of oxygen to-day is produced by the liquid air process or the electrolytic process. The principle of the liquid air process is simply the reducing of the temperature of air by compressing and expanding in a chamber to a temperature at which it becomes liquid, and then by taking advantage of the different boiling points at which nitrogen and oxygen is given off; the nitrogen boiling off at approximately 194 degrees centigrade below zero, leaving the oxygen, which is boiled off at a temperature of 184 degrees centigrade below zero. At this point the oxygen is collected, purified and compressed.

The electrolytic process of producing oxygen, which has been so generally known in laboratories, the principle of which is to ionize the water by inducing an electrolyte, and then passing a direct current through the water. The oxygen is given off at the anode, and the hydrogen is given off at the cathode. The oxygen is then collected, dried, purified and compressed. The manufacture of oxygen electrolytically for a long time was retarded owing to the difficulty of developing an electric cell in which the oxygen and hydrogen would be given off absolutely separate, as it was important that these two gases should not be mixed to any degree.

Influence of Impurities of Oxygen.

It is of considerable importance that the Oxygen should be as pure as possible. The impurities which decrease efficiency are nitrogen or hydrogen. When oxygen is prepared by the liquid air process, a certain percentage of nitrogen is always certain to be present. Nitrogen tends to cool the heating flame. In the manufacture of oxygen by the electrolytic process, the only impurity is hydrogen. The effects of the presence of nitrogen are especially noticeable when cutting

operations are done by the Oxy-Acetylene or Oxy-Hydrogen cutting torch. Experiments have been carried out in order to determine just how serious the effect of Nitrogen in oxygen is. These experiments show that the purity of oxygen plays a most important part in the efficiency with which the cutting operations may be accomplished. S. W. Miller, a recognized authority, claims that with Oxygen about 85% pure, it requires about three times as long to cut a plate an inch thick as when the oxygen is 99% pure. Even the one-half of one per cent. drop from 99% oxygen to 98.5% quality means a decrease in efficiency of 16%. Hence, even if the better grade of oxygen costs more, it is apparent that this expense is justified. It will readily be seen from what I have just said that the best oxygen commercially is produced electrolytically, and even considering the guarantee given by the manufacturers of either of these processes as to the purity is evidence enough that where possible oxygen from the electrolytic process should be used.

Acetylene.

Acetylene Gas can be obtained in tanks either containing 100 or 300 cubic feet respectively, at a pressure of 225 lbs. All Acetylene Gas is made by slaking calcium carbide with water. However, if Acetylene Gas is used in any quantity, it is cheaper, and a better gas is obtained by the installation of a Generator.

The most commonly used generators on the market can be classified into three classes, namely: What is known as the "Carbide to Water," in which the carbide is dropped into the water; "Water into Carbide," allowing the water to rise slowly against the carbide, or "Dropping the water on the carbide." The first two types, however, are the only two which will be found in this country. To quote S. W. Miller again, the first, namely, "Carbide to Water," is by far the safest method, it keeps the pressure uniform, gives a purer gas, and in every way is to be preferred. It is interesting to note that in the regulations laid down by the Underwriters Laboratories at Chicago, the "Carbide to water" is given preference."

Fluxes.

Those who are familiar with Oxy-Acetylene welding are aware that fluxes, scaling powders, are used; but it is not generally known why the use of these fluxes is necessary.

They are sometimes used in the shape of powders into which the welding-rod is dipped, thereby transferring the flux to the weld, or they may be incorporated in the welding-rod itself. Also a special welding-rod containing certain elements may be used in connection with a powdered flux. Inasmuch as each metal has different characteristics and requires different treatment during the welding process, the nature of the flux varies with the metal. Therefore, it would be well to consider each metal separately, first explaining the nature of the difficulties encountered and then describing the remedies which are applied, including, as far as possible, the materials used for making the fluxes. It should be stated here that the manufacture of satisfactory fluxes requires considerable chemical knowledge, and in the majority of cases should not be undertaken by a welding shop, because of the difficulty of obtaining the proper amount of the necessary elements and mixing them properly, and because it is cheaper, as a general rule, to buy the fluxes from the manufacturers than to attempt to make them.

The use of flux in the case of aluminum welding is particularly interesting, inasmuch as it has only been recently developed. The difficulty to be overcome is that the oxide of aluminum is considerably heavier than the metal itself, and the use of a flux is necessary to eliminate this oxide. The flux used must be a very active agent, and is comparatively complex chemically. It is enough to state that satisfactory fluxes have been produced for aluminum. Welding can be done if the necessary precautions are taken and proper fluxes used.

The industry of welding and cutting has developed to the point where no machine shop can be considered complete without a welding apparatus, either electric or oxy-acetylene, and a cutting equipment, either hand equipment or automatic.

The function of such an address as I have endeavored to give this evening before this Club is to outline a subject broadly which will serve as a basis for discussion, and I am certain that simply the defining of the separate fields best suited for the different processes in itself will give rise to discussion.

Chirman:—

Gentlemen, we have listened to a very good paper from Mr. Ludington and would like to have a good discussion on this subject.

Secretary:

I think, Mr. President, it would be a good move if some of our railway representatives would ask Mr. Barry a few questions on this very important subject—or perhaps there are representatives of some of the big industrial works here who would join in the discussion.

Mr. G. E. Parks:—

What is the relative value of Oxy-Acetylene compared with Carbo-Hydrogen when employed particularly to remove rivets? Which is considered the better process?

Mr. W. H. Ludington:—

The hydrogen is used to replace the acetylene in some cases for economy, as the hydrogen is produced as a by-product of oxygen in the electrolytic process, but generally the oxy-hydrogen is used for the cutting of thick metals. it being found that the character of the oxy-hydrogen flame differs slightly from the oxy-acetylene flame, inasmuch as the flame is hotter through its length and it is found cuts the thicker metals more satisfactorily, in fact, for extremely heavy cutting the oxy-hydrogen flame must be employed. But for rivet cutting the main difficulty is pre-heating the rivets, and this takes up the greater part of the time required for cutting rivets, as once the rivet is pre-heated it will burn very quickly. The temperature of the oxy-hydrogen flame is about 4,000 F., and the heat generated by the oxy-hydrogen flame is only about one-quarter the heat generated by the oxy-acetylene flame; therefore, it is apparent that the oxy-acetylene is the best flame to use for rivet cuting.

Mr. G. E. Parks:—

I mean the Carbo-hydrogen process. I understand they have a process of that name for cutting rivets. When you cut a rivet with the oxy-acetylene process, the heat practically welds the rivet in its place and makes its removal difficult or more so than if you use some other gas which I believe they call carbo-hydrogen.

Mr. W. H. Ludington:—

I have not heard of that. It has been my experience that in cutting rivets it is best to use the oxy-acetylene process. I have never heard of carbo-hydrogen in Canada or United States. There are specially designed torches and tips for rivet cutting.

Mr. L. Brown:—

We have a subject to-night which is very interesting. particularly so to those of us who have not had as much experience as we would wish with all the new processes mentioned, but it appears that we may have gone too far in some respects along the line of welding in our efforts to reclaim a good many classes of material, and while in many cases, it is a boon to the railroads to have these processes, the American Railway Association is finding it necessary to consider restricting welding on certain parts of cars, and I think we have gentlemen here to-night who can give us some information as to what are the limits of the various processes in their respective fields. I recently had occasion to get some tests made of oxy-acetylene and electric welding on quarter inch rolled steel sections and the result of the tests showed that while the electric welded joints were stiffer and stronger than the original section, the oxy-acetylene welds failed. I was wondering if Mr. Ludington or Mr. Barry could give us some idea of about what kinds and thicknesses of steel they would recommend for the oxy-acetylene process. I think such information would be of benefit to many of us.

Mr. A. M. Barry:—

The limitations of oxy-acetylene and electric welding of steel are very indefinite. With the oxy-acetylene process rolled steel are very indefinite. With the oxy-acetylene process rolled steel or mild steel sections, with a skilled operator making proper use of his flame, with correct amount of oxygen and acetylene gases to give a neutral flame, and using the proper selected metal rods—up to 2½", a weld 98½% as strong as the original metal should be obtained, and with better elongation than in the stock material. Most failures in the lighter sections are the results of unskilled operators. The welding rods have to be carefully selected. Electric welding, as known to the trade, is not as strong as the oxy-acetylene process for brackets, or shafting, etc. Usually we figure that an electric weld will give us 80% of the strength of the plate and we figure 90% for oxy-acetylene welding in working plate up to one inch. I think your failure and your test would show that your oxy-acetylene welder was not using proper welding rods. We have had tests made repeatedly and we find that the oxy-acetylene weld is at least 98½% the strength of the original bar up to one inch in diameter. If we get a new operator and wish to put him on important work, we give him some bars and watch how he

welds them. Then they are tested, and as a result of this test we are able to tell whether he is a skilled operator or not and whether he knows how to select the material he is going to add. This has a very important bearing on the result. If we get over 3½″ sections in steel, it is then time to use Thermit. As Mr. Ludington said in the paper to-night, we did not do justice to the oxy-acetylene welding process, as this process is practically unlimited. We have made successful welds in cast iron with this process, one of which was melting in 800 lbs. of metal on a broken bulldozer frame; it was used during the early stages of the war, and it has been in daily service since that time. If we could have obtained the men, we would no doubt have used Thermit, but we did not have the men and for that reason the oxy-acetylene process was used and we made a very good job of it. So that you might say the dividing line between the three processes is more or less indefinite, and it is up to the skill of the men handling it and the kind of work they do. Electric welding is not usually considered as strong as oxy-acetylene welding and is not as strong as Thermit welding.

Mr. F. R. Wickson:—

I should like to ask if any figures are available showing the relative cost of oxygen as between buying it from a manufacturing plant or producing it in a plant of your own.

Mr. W. H. Ludington:—

That depends upon the quantity of oxygen required. If you buy an occasional tank from the service stations, the cost is considerable, but some large customers get a price as low as 1¾ cents and lower, and some pay as high as three cents. For electrolytic oxygen, it is generally worked out on the basis of three cubic feet of oxygen to one k. w. hour electric energy. The cost of installing a plant to generate the oxygen is considerable, and a plant that would produce about 10,000 to 15,000 cubic feet per working day would cost something between $50,000 and $75,000 installed, including tanks, etc. The big drawback to any oxygen plant is the initial expense which is very high, although the operating expenses are comparatively low. It depends on what you have to pay for your electric power, the quantity of oxygen used and the present available service.

Mr. H. Payne:—

So far as my experience in welding is concerned, I have seen a lot of this work done both with the oxy-acetylene and the electric, although I am not a welder. The work on cast iron is not satisfactory. It seems to me that with cast iron when you get your job done you never feel satisfied or that you are getting a safe job. Mr. Barry has spoken about the operators. There is always an excuse when the weld does not turn out right. Either you have not used a skilled operator or you have not used the proper quality of cast iron to make the weld with. From my experience, I have very little faith in cast iron welding, and from the number of castings which have broken after being welded I am satisfied that the oxy-acetylene welding of cast iron does not come up to the standard. This excuse of the unskilled operators and not using proper iron does not go with me.

Mr. R. H. Black:—

The speaker of this evening has brought up a point that is very interesting to me, but I would like to ask where we are going to get experienced welders from? Welding is comparatively new and you cannot obtain men who have served any apprenticeship. It seems to me that instead of taking helpers or laborers for this work, which appears to be the common practice, we should use machinists, as there is no class of work in which success depends so much upon the skill of an operator as welding, and it is not until the weld has failed that you know whether it is a success or not. I would like to see the welder raised to a better status than at present. He should be a mechanic instead of a helper. There is a question I would like to ask, and that is whether the oxygen used for welding could not also be used in the case of accidents where men may be overcome by gas on account of going into sewers or other places. Is it safe to use the ordinary oxygen for this purpose?

Mr. W. T. Hawes:—

I note the discussion has brought out the point that the quality of welding done depends upon the skill of the operator. I should like to ask if the question of forming schools has been considered or has anything been done to insure the training of these men?

Mr. A. M. Barry:—

In Canada we train our own operators to-day. There is a school which is run either by the Government or some college institution where welding lessons are given and after a dozen of these lessons they turn out what they call a first class welder. In France, where they have it down to a science, they take young boys from 16 to 18 years of age and send them to a technical school where they are taught all about oxygen and acetylene. These boys are given a mechanical training and they give them a highly technical training as well. When they come out of this school they know the theory of it down to perfection and they are then apprenticed to a first class welding works for a period of four years; in other words, the French government claim that these oxy-acetylene welders are entitled to a first-class welder's certificate which enables them to do any kind of oxy-acetylene welding. These boys have to put in eight years learning the trade. I can take a laborer and teach him how to cut in two or three days. Anybody can do the same if he has been told how to light his torch and apply the oxygen. Any ordinary laborer can be shown in a few minutes how to cut up steel scrap or old boilers, etc., and in three or four days can learn how to do this class of work, but the French Government claim that it takes eight years to make a first class oxy-acetylene welder. In England there are similar schools run by the Government and there is the British Welding Association, which is working along the same lines. I think the term of apprenticeship is as long as it is France. To-day in Canada a boy goes up to the technical school and gets eight or ten lessons and he is then a first class welder. He goes into the welding shop and makes a lot of noise, but when he comes to do the work hė gets a black eye. The result is that all large welding works train their own men. The Soldiers' Civil Re-establishment are undertaking to teach the men to become welders in eight months, and while they get along fairly well, it is impossible to learn this trade in that time, although they may be able to handle certain repetition work very nicely. A first class man, however, should be able to weld any kind of metal and any combination of metals. There is no limit to what he is asked to do. To-day he works on a brass casting, the next day it is an aluminum crank case, and the next day he tackles big cast iron castings which will take 100 pounds of metal to make the weld. On the other hand, repetition work can be learned very easily. During the war several shops in France had over 500 operators work-

ing at one time, and one shop had over 1,200 working at one time, and most of these operators were women who had been at the work for only a couple of months making up bombs and depth bombs. It was simply a case of repetition work. The French Government had a lot of apprentices to show the women how to do the work and in a few days they could do it very well, according to results.

Someone has made the statement here to-night that they had no faith in oxy-acetylene welding of cast iron. I may say that I am not interested in processes or apparatus. We are a welding concern pure and simple, and we do not care how we do the job, but use the best process for the job. At least 90% of the work that comes to us is cast iron and 97% of that work is done by the oxy-acetylene process. It comes to us in all sizes, shapes and conditions, from little castings weighing a few pounds to castings weighing several tons. When we get through here to-night, we are going to go down and tackle a big cast iron job by the use of Thermit welding. If any of the gentlemen here want to see this work, we shall be glad to have them come along. It will take place about two o'clock to-morrow morning. As I said before, 97% of our cast iron welds are made with the oxy-acetylene process and our failures are less than one-tenth of one per cent., — so I think we can get back and look at the operator and not the process. If a job fails in an industrial shop, the operator is never wrong—his gauge, or his oxygen or the acetylene is not right or the rods from the stores are wrong, but he is never wrong. With us who do welding commercially, it is different. If we make a failure we not only get a black eye but we do not get paid, and we find out what is wrong. Excuses do not get by. If the weld fails, it is up to the operator and no excuses are accepted. It is a poor workman who quarrels with his tools, generally. I think this is an answer to the point which came up to-night.

We have some cast iron jobs coming into the shop from time to time which are welded by electricity, but they are freaks pure and simple, and are not commercial jobs. The method of welding cast iron by electric welding is to open the break in the usual manner and put studs into the "V," then fill it up with a mild steel welding rod by the electric process. You are not welding cast iron by the electric process. You are welding steel on steel studs and when the added metal is put under a microscope, we find there is a distinct line of slag between the added metal and the cast iron. There is a flux some works use which assists in breaking

up the slag, but the results are very indefinite, and commercially we always use the oxy-acetylene process for cast iron where the jobs are ordinarily small, but in large sections it is best to use Thermit.

Mr. H. Payne:

I am still dissatisfied. I have not yet seen any casting with ribs or flanges that could be said to be as strong as before it was broken, and there is always contraction and expansion taking place. So far as steel welding is concerned, we have got satisfactory results, but with cast iron we have never got a sound casting from oxy-acetylene welding.

Mr. A. M. Barry:—

I can only repeat, do not blame the process, but the operator. If you cannot get the work done in your shops, send it down to us and we will do it; no job, no pay. (Laughter.)

Mr. Petersen:—

I think Mr. Payne has just mentioned a point that it is necessary to consider, and that is the expansion and contraction. In welding cast iron, a large piece has to be handled with good judgment and the man in charge has to consider each job on its own individual merits. He must heat it in such a manner that after the welding has taken place, the whole thing will contract together. In addition to this, you must have a careful operator to direct the flame. For small castings, welds can be made successfully by the electric process as Mr. Barry has explained.

Mr. F. Phillips:—

Mr. Barry has stated that in ordinary large jobs Thermit should be used. Does the threading of the studs assist in this work, and by using Thermit in quantities,—how does this work out? In filling a large hole you want to get strength in the material as well as in the filling.

Mr. A. M. Barry:—

The gentleman has confused electric welding with Thermit welding. The statement I made was that Thermit welding was used on large cast iron sections and that freak cast iron jobs could be welded by the electric process with the assistance of studs.

Mr. F. Phillips:—

What is the efficiency in welding iron to the studs?

Mr. A. M. Barry:—

The efficiency of Thermit welding cast iron is over plus 5%, and it runs up as high as plus 12%.

The Secretary:—

If there is no further discussion, Mr. Chairman, I should like to propose a very hearty vote of thanks to Mr. Ludington and Mr. Barry, also to the other gentlemen here. As your Secretary, after notifying some 1,300 members of this meeting, I had to make good, and I believe everyone here will bear me out in saying that we have had a most interesting paper.

Mr. N. Holland:—

An Irishman was once asked what he thought of the New York Subway—he said it was alright as a "hole." Welding seems to be alright "for a hole." We are always pleased to see Mr. Barry here, and I am glad to second the vote of thanks to Mr. Luddington and Mr. Barry. We always feel that when Mr. Barry gets up to say something about welding, he knows what he is talking about. I was interested in the statement made this evening that Oxy-Acetylene had not been a success in welding cast iron. I know a good many plants in which it has been used successfully. It always seems to me to be a pity that any process should be knocked because it may not have been a success in any one particular operation or plant. There may be a good reason for it, as they may not know how to do the work successfully. The "proof of the pudding," is as Mr. Barry says: "If we do not do the work right, we cannot expect to get paid for it." When Thermit first came in, a friend of mine in the United States had a great deal of work done by the process, and made many successful welds. He was enabled to get the work done quickly and in such a way that it would stand. I think you will all admit that in these processes about 90% of the success or failure of the work depends on the operator. Do not put the blame on the process without looking into the matter. When the operator fails, he will naturally try to put the blame on the process in order to hide his own faults. I take pleasure in very heartily seconding this vote of thanks to Mr. Barry and Mr. Ludington.

Chairman:—

It has been moved by the Secretary, seconded by Mr. Holland that a hearty vote of thanks be extended to Mr. Barry and Mr. Ludington for this paper. Carried.

At the next meeting we shall have a paper by Mr. F. Williams, Mechanical Designer, Canadian National Railways, Moncton, N.B., on "Locomotive Valve Gear." The Secretary has arranged for the usual sandwiches and coffee in the room at the rear. I hope all will stay, partake of them, and become better acquainted with one another.

ANNUAL BANQUET.

The Seventeenth Annual Banquet was held in the Green Room of the Windsor Hotel on Saturday evening, January 31st, 1920.

There was an exceptionally large gathering of members and their friends, including among others, Hon. Arthur Meighen, Minister of the Interior, Rev. George Adam, W. M. Neal, late Secretary, Canadian Railway Board, R. M. Hannaford, W. McNab, A. A. Goodchild, A. A. Maver, J. Coleman, W. A. Kingsland, Norman Holland, W. H. Robb, E. E. Lloyd, W. A. Booth.

The tables were very prettily decorated, a notable feature being a miniature railway train winding its way through tunnels, around artificial lakes, etc. The menu cards being prepared in artistic style, an aeroplane decorating the top, emblematic of the soaring heights the club was reaching out to.

The President, Mr. J. Hendry, occupied the chair, and was ably assisted by Mr. L. C. Ord as toastmaster. Immediately after dinner was served, the toast of "The King" was announced, which was pledged with enthusiasm, those present taking up the refrain when the special orchestra engaged started playing the "National Anthem."

Mr. W. H. Winterrowd, Chief Mechanical Engineer of the Canadian Pacific Railway, then proposed in some well chosen remarks the toast of "The Railways," giving emphasis to the special services rendered by them during the past five years. He also made mention of some early history of our Canadian Railroads. This was ably responded to by Mr. W. M. Neal,

who told of the effectiveness of the co-operation of the railroads under the auspices of the Canadian Railway War Board, whereby there had been great saving in labor, in cost of tonnage carried and many other matters.

This was followed by the toast of "Our Guests," which was proposed (in his usual able manner) by Mr. T. C. Hudson, General Master Mechanic Canadian National Railways, and, in concluding, Mr. Hudson coupled the names of Hon. Mr. Meighen and Rev. George Adam for reply to same.

In part Mr. Meighen pointed out that the process of railway amalgamation in twenty years had progressed to such a stage that within the immediate future there will be two systems that will own and operate the great bulk of trackage. and the strain of his argument was that there was a sort of tendency on the part of circumstances to lead up to entire nationalization as the ultimate goal. The Government had not sought and was not seeking railroad ownership, but it was becoming owner and operator owing to the march of events. It involved the greatest railway responsibility on the globe, but he felt that the nation was equal to the task.

He stated that railway organization to-day and railway business are the most perfect of individual services in the world, and in no country in the world have the railways played so big a part in the nation's service, relative to the population and business of the whole country, as they had in Canada. That was an opportunity that was ours by reason of the fact that while numerically not a large nation, geographically we are an immense country; consequently transportation bulked large in the business and service of the country. "It is no more than justice to the railway men of Canada and to the nation to say that we have, of all countries in the world, the best service per capita in railway matters that can be found anywhere. Go to Great Britain, to the United States, to the continent of Europe, and you cannot travel in more comfort nor with greater safety, and you do not see the marvels of business efficiency in greater degree than in Canada, and in the recent war the railways stood up to the needs of the hour better than in any country of our allies or foes."

Railway Mergers.

Twenty years ago, Hon. Mr. Meighen said, there had been more railways in Canada than to-day, the progress of railway organization having been in the direction of enlargement of the railway unit, thereby gaining greater efficiency, larger

capitalization and concentration of business. The country is now at the stage where it has, according to a previous speaker, 42,000 miles of railroad, but it is not very far from the stage when it will have only two railway organizations; in fact, within the very immediate future there would be two major railway organizations embodying and embracing not less than 34,000 miles of the trackage of this country, and the remainder would have among them the fragment that was left. "Where that is to bring us in the long run, it is difficult to say," added the speaker, "but if we can learn the lesson of the future by reading that of the past, it will probably bring us more and more to the time when railway organization matures into public control and, indeed, into public operation itself. I am not speaking the words of a dreamy Socialist when I say that the future of our railways' life, as indeed in other lines of human activity, belongs to a purified socialism. How far the day is ahead when that time comes we do not know, but I believe that after the lapse of years the railways running to-day under various ownerships and always becoming fewer, may mature into one great organization more or less the property and responsibility of the State.

"It does not follow that I would to-day do anything to bring another single mile of road under the ownership and operation of the State; I believe more is to be lost by pushing forward in advance of a necessity than is to be lost by waiting until necessity imposes that duty upon us, and, moreover, we have already reached a stage where we operate 9,800 miles of line. We reached that stage not because we were seeking to hasten the day when government responsibility should be greater by reason of railway operation, but because the march of events and the stern hand of necessity compels us to take the position and responsibility we have assumed, and if steps are taken in the years to come in the same direction, they will be taken not because governments are striving for new responsibilities, but because the same march of events will press and compel the Government to take that course, because that is the course along which business evolution is moving and will move.

Not Fearful.

The Minister further said that when the Grand Trunk was finally acquired, the Government mileage would be 22,000 miles. "It will be the largest railway responsibility assumed by any single organization on the face of the globe. That is something for a country with our population to assume, but I

am not fearful. I am not fearful by virtue of the type of citizen that we have reared in this country that we will fail in our great responsibility. One thing, however, we must look to; we must see to it that the incentives to effort and the rewards for efficiency that have made private ownership succeed, are present in equal degree in any government organization; we must see that men who bring success to railway service may look forward to legitimate promotion and advancement such as they would enjoy in any business institution. A business institution owned by a government can succeed on that condition and no other.

On the subject of the Grand Trunk, Mr. Meighen said he was not going to enter into an analysis of the problem. "I pass that subject up only with the statement that that acquisition, like the previous one, was not brought about through any restless ambition to become great railway operators and owners, but it was the result of our railway crisis, the result of some mistakes and indeed of the very evolution of railways. But a country that has contributed 640,000 men in the great struggle for liberty that has ended in triumph, does not need to quail before the task of managing thousands of miles of railway even under a government system."

Mr. Meighen concluded by touching on present-day problems of reconstruction, the clash of many groups; said we had made many mistakes in railway enterprise, but none from which we could not recover. He looked for a population of fourteen millions before the corner of another decade is turned, and if we had that, then we would soon recuperate from any errors, and there would be no difficulty in fulfilling our obligations.

A New Suggestion.

The Rev. George Adam, who followed the Minister of the Interior, in replying for the guests, gave a light touch to the proceedings by some appropriate humor, and then tendered a little advice. The distribution of commodities, vital as it was to the industrial welfare of the country, was not the only sort of distribution that the country required. There was the distribution of wealth, which was one of the crying necessities of our time. There would never have been the late convulsions in the world if there had been anything like an adequate distribution of the wealth that was created in the respective countries. The statesman tried to distribute wealth on the basis of taxation, but the distribution of wealth must before long be tackled on another basis if there were to be happy and

contented workpeople. There was also a need for distribution of ideas. Every child of rich and poor should have the same right to receive from the distribution of ideas through the medium of education. The only hope of Canada's future greatness lay in the distribution of her ideas on a larger scale than ever before.

Mr. W. H. Sample, General Supt. Motive Power and Car Departments, Grand Trunk Railway System, then proposed the toast of "The Railway Supply Man."

In his remarks he paid a very high tribute to that fraternity and the great assistance they rendered the railways. He stated they also were ready and willing at all times to help this Canadian Railway Club, which the Executive appreciated.

Mr. Sample, in closing, called upon Mr. H. H. Vaughan, of the Dominion Bridge Co., and Mr. J. M. S. Carroll, of the Canadian Consolidated Rubber Co., to respond, and this was well taken care of by both and in a manner as only railway supply men can handle the (Goods).

These various speeches were interspersed with instrumental and vocal music and skits which were all much appreciated. and the evening's entertainment was brought to an end by the singing of "Auld Lang Syne" and the "National Anthem."

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